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(54) IMPROVEMENTS IN OR RELATING TO PROGRAMME-CONTROLLED DATA PROCESSING SYSTEMS

(71) We, SIEMENS AKTIENGESELLSCHAFT, a German Company, of Berlin and Munich, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to programme-controlled data processing systems.

Very high requirements are made on the reliability of programme-controlled processing systems above all when these are processing systems which, for example, like a programme-controlled telecommunications exchange system, must be constantly ready for use. In no case may the breakdown of individual system units lead to a breakdown of the entire system. To increase the reliability it is known to increase the redundancy of a system for example by providing the entire system in duplicate or by providing individual units of the system in duplicate. Furthermore, to increase the security and reliability it is known to make individual subsidiary regions of the system to be interchangeable. In data processing technology this manner of system construction is termed "modular construction", in each case an interchangeable system part, in the following called a system unit, being termed so-called module.

However, the reliability of a processing system does not only depend upon the entire system continuing to operate without interruption, in the case of the breakdown of one system unit, but it is of equally great importance to be able to constantly check and monitor the mode of operation of the system even during the fault-free operation. For this purpose it is known to compare the results of processes taking place in the multiply provided system units or to periodically run test programmes, so-called routine tests. In the frame of routine tests of this kind it is known to determine the required and the actual operational reliability in that in the course of a routine test programme the operational voltage of a system unit, i.e. the voltage at which the unit is operating, is varied in order to establish whether deviations in the operation occur. The operational voltage is generally reduced or increased within the prescribed limit range of the unit. This method is known as a marginal check. The results of particular test operations carried out by the system operating at the increased or lowered voltage are compared with results which would be expected from a perfectly operating unit. Tests of this kind indicate whether or not the unit is operating correctly and it has been proved that such a variation of the operational voltage is a very good aid both in the early detection of faults and also in the finding of faults.

The present invention is also concerned with the problem of making it possible to check units of a modularly constructed, programme controlled processing system by varying the operational voltage.

According to the present invention there is provided a method of testing a data processing system including a central store, a signal station and a plurality of system units, one of which is a programme control system unit and each of which is assigned a current supply device, comprising issuing a piece of command information from the programme control system unit and transferring said command information via a standard system interface, via which the system units may exchange information and control criteria with one another, to the signal station, then analysing said piece of command information in said signal station and forming therein a piece of signal information, then passing said piece of signal information to a particular one of said current supply devices thereby to modify the supply voltage of said current supply device, and then forming a piece of reporting information indicating that said modification has been effected and reading said piece of reporting information via the standard system interface into a part of the central store.

Each current supply device may be reset to its normal voltage, via the signal station

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through which its voltage was modified, under the control of a programme.

Alternatively, a current supply device whose voltage has been modified may be reset to its normal voltage via a special resetting line.

The signal station, which is reached by means of a modification command issuing from a programme control unit of the system, can be centrally or decentrally arranged. In the first case the signal station may be reached via the standard system interface. This can take place in known manner in that by setting an application bit in the central part of the processing system, a programme control unit emitting a modification command makes an application for a storage cycle to transfer the programme to the signal station. After the piece of command information has been decoded in the signal station, a specific current supply device may be reached from the latter, which device is then passed an appropriate piece of signal information which causes the modification in the operational voltage in the relevant current supply device.

In the second case, every system unit or part system unit, whose current supply devices are to be included in the programmed voltage modification, is assigned a signal station of this kind. The commands emitted by a programme control unit are here passed in known manner to a specific system unit, whose current supply devices are to be modified. Also in this case, the modification command is correspondingly introduced by programmes which take place in the programme control units. However, the system unit which is to be checked is in each case competent to effecting the modification in the current supply devices. The decentral signal stations can here either be provided as part of the system unit which is to be checked or as separate units. Apart from these two possibilities for the arrangement of the signal stations, these can also be arranged partly centrally, for example for a specific group of system units, and partly decentrally.

The execution of a command, which causes modifications in the operational voltage is acknowledged by the individual current supply devices by a piece of reporting information which is available to the central part of the processing system for the purpose of monitoring. This can take place, for example, in that the pieces of reporting information are collectively conducted to a central interrogation device from where they may be reached in the frame of a programme. Thus they can be input into a specific storage zone of the central store and are then available to a test programme, which can monitor both the execution of modification programmes, and also the correctness thereof, for example by comparing the pieces of information which trigger the modification with the pieces of information which arrive after the modification has been effected.

The resetting of the individual current supply devices into the operational state during which they emit the prescribed operational voltage, can take place by means of an appropriate command or by a compulsory resetting of the relevant current supply device. In particular for the last mentioned possibility, with particular advantage a resetting line is provided which may be driven by the interrogation device and which is conducted for example in the cable via which the pieces of reporting information are transmitted. The possibility thus exists of maintaining the current supply devices at their operational nominal value even when the signal stations are operating in faulty fashions.

It has already been proposed (see Published German Specification No. P20 12 052 .9 for programmed fault finding in a programme-controlled processing system, to set a faulty system unit in a special diagnosis state during the duration of which the faulty system unit can communicate only with those fault-free system units of the remainder of the system which are likewise either constantly or occasionally in the diagnosis state. The advantage is thereby obtained that during the time their diagnosis programme is running faulty system units communicate with other system units only when these other system units are also in the diagnosis state. Any fault which might occur then cannot affect the entire system. Taking this proposal as a basis, it is further proposed in accordance with the invention that the modification in the supply voltage in current supply devices which are assigned to the system units directly connected to the standard system interface which takes charge of the traffic between the individual system units be effected only when the corresponding system units are in the aforementioned diagnosis state. The modification of the supply voltage in a current supply device, on the other hand, which is assigned to a system unit connected via further external interfaces to the system units which are directly connected to the standard system interface, is advantageously executed only when the system unit, via which the first mentioned system unit is connected to the standard system interface, is in the operational state.

The present invention will now be described by way of example and with reference to the drawings, in which:

Figure 1 is a block circuit diagram of part of a data processing system in accordance with the invention; and

Figure 2 is a block circuit diagram of part

of a further form of data processing system in accordance with the invention.

The processing system represented in Figure 1 consists of a series of system units SE which, in accordance with their mode of operation in the system, are designated line connection unit, programme control unit, device connection unit, and storoge unit. The modular construction of the processing system becomes manifest in that the individual system units are each provided in duplicate. For this reason, in each case two line connection units LE1 and LE2, two programme control units PE1 and PE2, two device connection units GE1 and GE2, and also two storage units SP1 and SP2 are provided in Figure 1.

In a system of this kind, the traffic between the individual system units always takes place in cyclic fashion via the so-called standard system interface SNS which connects the individual system units. For this purpose each system unit is connected to the standard system interface via lines for the transmission of control criteria and for the transmission of information.

This takes place, as is known, in such manner that a system unit which wishes access to another system unit transmits an application for a cycle, which is analysed in a store programme control unit SAS1 and SAS2 and lead to the assignment of a store cycle. The information exchange then takes place within the assigned store cycle.

Each system unit is assigned a current supply device SV, the voltage values of which may be varied, in accordance with the invention, in programmed fashion. For this purpose a signal station LS is provided which is connected to the standard system interface SNS in the same way as a system unit and thus may be reached from all system units and also possesses access to all system units.

Each current supply device may be reached as required via the signal station LS. The current supply devices themselves are connected to a central interrogation device AE via a reporting line ML. Likewise they may be reached from the central interrogation device AE via a resetting line RL. The reporting line and the resetting line can here in each case be conducted via the wires of a common cable. The central interrogation device AE can, for example, communicate with the system via one of the device connection units, in Figure 1 via the device connection unit GE2.

The mode of operation of the system represented in Figure 1 will now be described. In the following, it is assumed that the transmission of signal information between the signal station LS and the individual current supply devices SV takes place via signal lines SL, each of which comprises 4 signal wires. In this way it is possible to undertake a modification in the operational voltage in 4 stages. Thus through the transmission of each case of a logic "1" on a particular one of the signal wires within a signal line, a 5% or 10% increase and a 5% or 10% decrease in the operational voltage can be obtained. On the other hand it is possible in each case to set the normal operational voltage by the transmission of a logic "0" on all the signal wires of a signal line. The invention is not, however, limited to the 4-stage modification of the supply voltage, and much more complex voltage variation arrangements can also be used.

The command for the modification of the supply voltage in a current supply device issues from one of the programme control units, for example from the programme control unit PE1. The latter sets an application bit in a part of one of the store programme control units SAS1. On the assignation of a storage cycle, which is either automatically assigned by the placement of the application bit, or is assigned by means of an interrogation pulse which issues from the signal station LS and reaches the store programme control unit at specific intervals of time, the piece of command information is transferred to the signal station LS, where the command information is decoded and passed, as signal information, via a signal wire of the signal line SL to a specific current supply device. The modifications in the operational voltage are transferred via the reporting line ML, as reporting information, to the central interrogation device AE from where they are available to the central store via the device connection unit GE2 and the standard system interface SNS. At the same time, in the frame of a programme running in the programme control unit PE1, the modifications which take place in the relevant system unit as a result of the variation in voltage are also available to the central section via the standard system interface SNS. This means that the mode of operation of the relevant system unit can be checked by a routine test programme as a result of the information available. The resetting of the operational voltage to the operational nominal value can take place either in programme controlled fashion, i.e. from a programme control unit via the signal station LS. It can also be effected, however, via the central interrogation device and the resetting line RL which possesses the advantage that even when the signal station is operating in faulty fashion, the current supply devices can be maintained at their nominal value or can be compulsorily reset to the nominal value.

Apart from the central arrangement of the signal station shown in the exemplary embodiment of Figure 1, a decentral arrange-

ment of several signal stations is also possible. The exemplary embodiment shown in Figure 2 illustrates this possibility.

The processing system shown in Figure 2 again contains the above mentioned system units SE, which are multiply provided and communicate via the standard system interface SNS with the central storage section which is likewise provided in duplicate. The essential system units shown again comprise a line connection unit LE, in which this time only communication control units UeAS1, UeAS2, connected to the standard system interface SNS, are provided in duplicate, two programme control units PE1, PE2, a device connection unit GE having device control units GS1,GS2,provided in duplicate, and central storage units SP1, SP2, the individual storage banks SB of which are connected to the standard system interface SNS via respective store programme control units SAS1, SAS2. The line connection unit LE, to which the feeders (incoming lines) and trunks, marked Z and A in the Figure, are connected, contains a series of system terminals SA, input-output code converters CW and the aforementioned communication control units UeAS1, UeAS2. The device control units GS1, GS2 possess access, via external device-interface adaption units GSA, to external devices which are not represented here. The current supply devices assigned to each system unit are again marked SV. The latter can also in each case be combined, as required, to form groups of supply devices. The signal stations LS are also provided and are arranged decentrally in the various system units. As it is possible to assign a decentral signal station, as an individual device, to a system unit or to design it as part of the system unit, both these possibilities are given in Figure 2. The first possibility is shown for the line connection unit LE and the programme control unit PE1 and PE2, whilst the second possibility is shown for the units of the device connection units (GS1, GS2, GSA) and of the storage unit (SAS2, SAS2, SB). Each current supply device SV is connected to the system unit which it is assigned via an energy supply line. The current supply devices assigned to the individual system units are connected to the signal stations of the system unit in each case via a signal line. In the exemplary embodiment, in the system unit termed line connection unit LE, the system terminals SA are each assigned a plurality of current supply devices, the input-output code converters CW are each assigned one current supply device, and the communication control units UeAS1, UeAS2, are likewise each assigned one current supply device. Similarly, in the system unit designated device connection unit, the device control units GS1, GS2, and the device interface adaption units GSA are each assigned one current supply device. The programme control units PE1, PE2 are each assigned one current supply device. Likewise, in the central part of the processing system, the store programme control unit SAS1, SAS2 are each assigned one current supply device, and the individual storage banks SB are each assigned a plurality of current supply devices. The transmission channels shown in heavy line in Figure 2 serve to transmit control criteria and pieces of information between the individual system units in the overall system.

For the description of the mode of operation of the system represented in Figure 2, it will again be assumed that the transmission of command information takes place via for example four signal wires of the signal lines SL, and thus it is possible to modify the supply voltage in four stages. However, it must again be remembered that the invention is not limited to the four-stage modification of the supply voltage. Likewise the command for modifying the supply voltage issues from a programme control unit e.g. the programme control unit PE1, and through transmission to a system unit is available, from the latter, to the signal station.

If the modification in the operational voltage is to take place in a current supply device which is assigned to a programme control unit PE1 or PE2, this is initiated by a special command of one of the programme control units themselves. It is advantageous to make the execution of this command dependent upon the fact that the relevant programme control unit is in the diagnosis state, i.e. when it has been set in a state in which it, apart from this command, can only communicate with other system units which are also in the diagnosis state.

If it is necessary to modify the operational voltage in one of the current supply devices which are assigned to a storage unit i.e. if a command is intended for one of the current supply devices assigned to the store programme control units SAS1, or SAS2 or for one thereof assigned to the storage banks SB, this command is initiated likewise by the application for a storage cycle, with which, however, an appropriate operations code is simultaneously connected. This command also issues from one of the programme control units PE1 or PE2. By the use of an appropriate address, a signal station assigned to a storage bank or a store programme control unit is passed the appropriate piece of command information. For the execution of the command, the said signal station emits a piece of signal information. The testing operation which then follows is thus executed when the relevant

storage bank or the relevant store programme control unit is in the diagnosis state.

The modification in the operational voltage in a current supply device assigned to the device connection unit is also initiated by a piece of command information which issues from a programme control unit. This passes via the signal wires of the signal line SL to the current supply device which is assigned to the device connection unit. If the modification command relates only to a device control unit GS1 or GS2, it is executed only in the diagnosis state of the device control unit. If the modification command on the other hand relates to one of the device-interface adaption units GSA, it is executed only in the operational state of the corresponding device control unit GS1 or GS2 and in the operational state of the device-interface adaption unit GSA.

Similarly, the current supply devices of the line connection unit LE are influenced by commands which issue from a programme control unit PE1 or PE2. In this case the voltage modification is initiated by a piece of command information which reaches one of the communication control units UeAS1 or UeAS2 in the line connection unit LE. If this command relates to a modification in the current supply devices assigned to a communication control unit, the corresponding communication control unit can be in the diagnosis state. If, on the other hand, a change is to be made in the voltage in a current supply device assigned to the peripheral units of the line connection unit thus a device assigned to the input-output code converters CW or the system connection units SA, the command is executed only in the operational state of the communication control unit. Also in this case, the modification in the current supply device of the peripheral unit of the line connection unit is effected from the signal station LS via the signal wires of the signal lines SL.

Further system units which are not represented in the drawing, such as for example a character processing unit, can also be checked in the manner described by means of appropriate commands which cause a modification in the operational voltage.

It has already been pointed out that the execution of a command which leads to a modification in the supply voltage is acknowledged by a piece of reporting information. In the present example, these pieces of reporting information are conducted via a special line, namely the reporting line ML, to the interrogation device AE. As the interrogation device AE can have access to the system in that it is connected to the standard system interface via the device connection unit, the pieces of reporting information can be made available to a storage zone, determined by the programme of the processing system, in the storage unit. Thus the execution of the programmed modification commands can be monitored therein by a test programme.

A central resetting line RL is also provided to which in each case one resetting wire in the signal cables is connected, this RL being fed by a suitable output device which may be driven in programmed fashion. Said output device can for example, be the aforementioned interrogation device AE. In this way it is obtained that all the current supply devices can be reset again to the normal operational voltage even in the case of a fault in the central signal station or the signal station provided in the system unit assigned thereto. Then the further advantage results that it is not necessary to provide the signal station in duplicate. This is shown in Figure 2 in an example of the line connection unit LE in which only one single signal station is provided for the two communication control units UeAS1 and UeAS2. In the case of a fault in the signal station LS, it will of course no longer be possible to pass modification commands to the units of this system unit, but the associated current supply devices in the peripheral units can be maintained at their nominal voltage via the central resetting line.

WHAT WE CLAIM IS:—

1. A method of testing a data processing system including a central store, a signal station and a plurality of system units, one of which is a programme control system unit and each of which is assigned a current supply device, comprising issuing a piece of command information from the programme control system unit and transferring said command information via a standard system interface, via which the system units may exchange information and control criteria with one another, to the signal station, then analysing said piece of command information in said signal station and forming therein a piece of signal information, then passing said piece of signal information to a particular one of said current supply devices thereby to modify the supply voltage of said current supply device, and then forming a piece of reporting information indicating that said modification has been effected and reading said piece of reporting information via the standard system interface into part of the central store.

2. A method as claimed in Claim 1, wherein, after said modification has been effected, the current supply device is reset to its normal voltage, via the signal station through which its voltage was modified.

3. A method as claimed in Claim 2, wherein the current supply device whose voltage has been modified is reset to its

normal voltage via a special resetting line.

4. A method as claimed in any preceding Claim, wherein the signal station is common to a plurality of system units and is reachable directly via the standard system interface and wherein the transfer of a piece of signal information which effects a modification in voltage in a current supply device in each case takes place via a signal line connecting the signal station to the current supply devices.

5. A method of testing a data processing system in which each system unit or part thereof is provided with its own signal station as claimed in any one of Claims 1 to 3, wherein the transfer of a piece of signal information which causes a modification in voltage in a current supply device in each case takes place via a signal line connecting the signal station to the current supply device.

6. A method as claimed in Claim 4 or Claim 5, wherein the voltage of the current supply devices, in dependence upon the signal information, varied in stages, and wherein the pieces of signal information which cause the modification are transmitted via wires running in the signal line.

7. A method as claimed in any preceding Claim, wherein the pieces of reporting information emitted by the current supply devices, after the execution of a modification in voltage, are passed to the store via a reporting line and via a central interrogation device.

8. A method as claimed in Claim 7, wherein the central interrogation device is connected to a device connection system unit.

9. A method as claimed in Claim 3 or any one of Claims 4 to 6, when dependent on Claim 3, wherein, to reset a current supply device into the state in which it supplies the operational voltage, a piece of resetting information is transmitted via the resetting line and wherein this piece of information is produced by a resetting device which may be reached from the standard system interface.

10. A method as claimed in Claim 9, wherein the piece of resetting information is transmitted via at least one additional resetting wire running in a reporting line and wherein the piece of resetting information is produced in the central interrogation device.

11. A method of testing a data processing system substantially as herein described with reference to Figure 1 or Figure 2 of the drawings.

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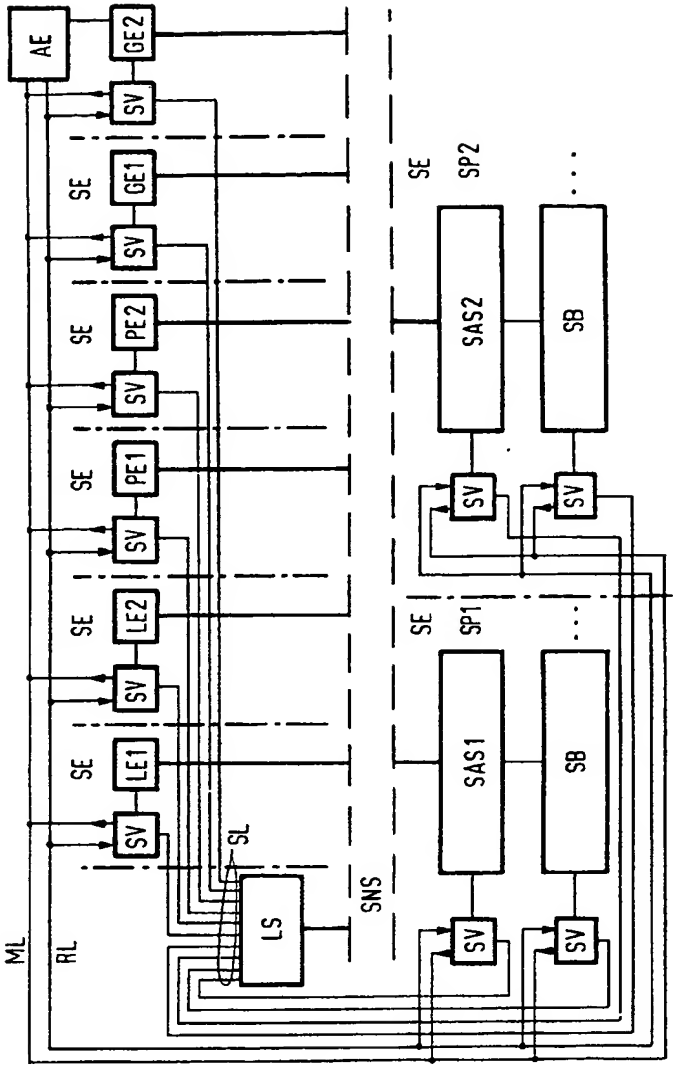
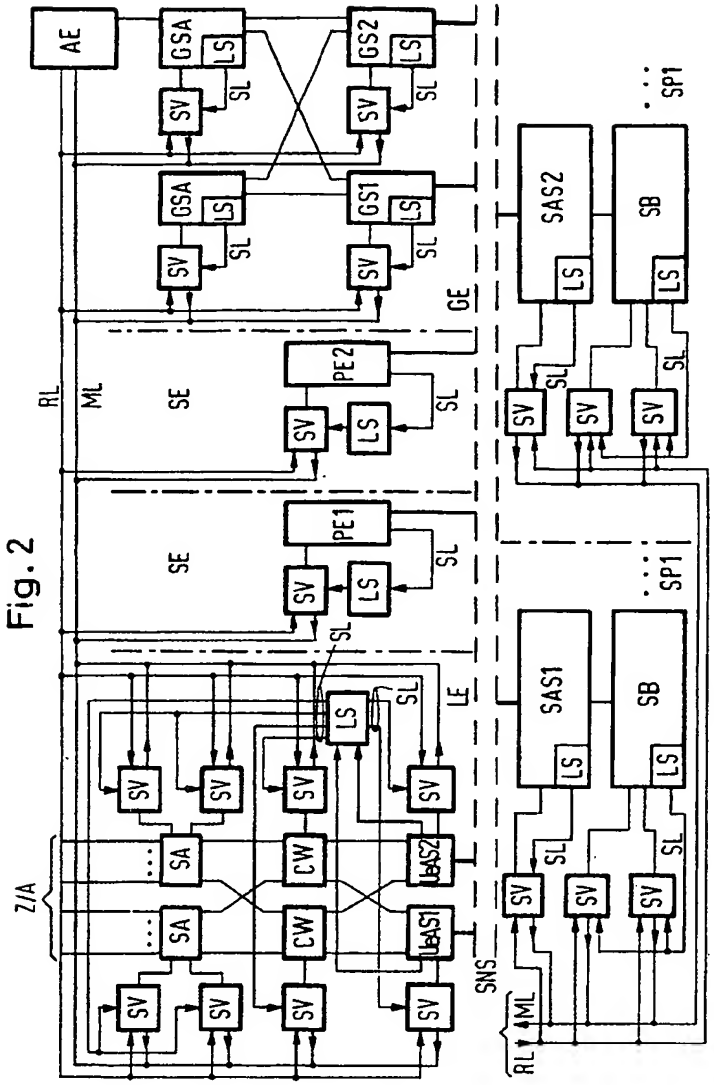
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

Fig. 1




AE
GSA
LS
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GS2
GS1
GE
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SE
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PE1
LE
Z/A
SA
CW
SAS2
SAS1
SB
SP1
SNS

Fig. 2